McCORMICK TURBINES

S. MORGAN SMITH CO.
YORK, PA.

Bulletin 110

McCORMICK TURBINES

MANUFACTURED BY

S. MORGAN SMITH CO.

YORK, PA., U. S. A.

BRANCH OFFICES

BOSTON	CHICAGO	MONTREAL
176 Federal St.	76 West Monroe St.	405 Power Bldg.

Cable Address
"Success"

Codes: ABC 4th and 5th Edition
Lieber's
Western Union
Bentley's

THE WORLD'S LARGEST HYDRAULIC TURBINE WORKS

S. MORGAN SMITH COMPANY, YORK, PA.

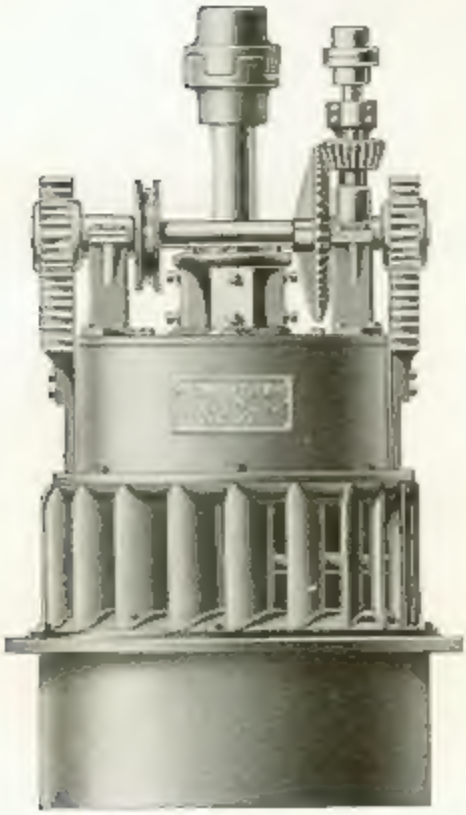
Introductory.

OUR purpose in publishing this Bulletin is to be able to present to our many customers, who are using the well known McCormick cylinder gate turbine, a set of tables giving the power, speed and water consumption of same, and also to meet the requirements where we quote on small turbines of this type to prospective customers who prefer a cylinder gate wheel.

This Bulletin does not represent the complete line of turbines built by this Company, as we continue to build the New Success turbine and also the Smith turbine. We have, also, designed and built many other types of turbines, some of which develop much greater capacity and higher speed than either the McCormick, New Success or Smith turbines.

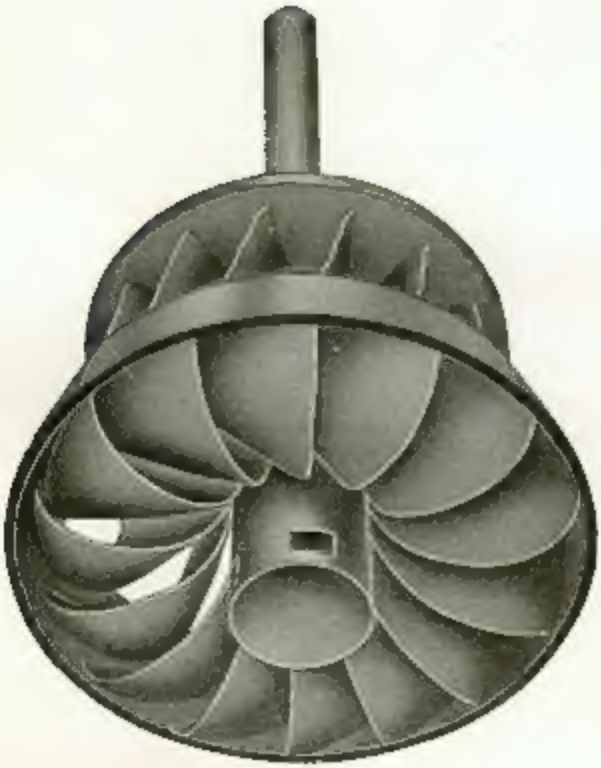
Those contemplating the purchase of turbine water wheels and accessories will find it to their interest to communicate with this Company as our designing and estimating departments are at all times at the service of our prospective customers.

S. MORGAN SMITH COMPANY,
York, Pa.



Engraving No. 401.

Represents the standard vertical McCormick Turbine. All wheels 24" and smaller will be shipped complete as shown. Larger sizes will be shipped in sections for convenience in handling.



Engraving No. 402.

Represents the standard McCormick runner with its shaft and cast iron step shoe. These standard runners are made of cast iron. Attention is called to the openings for water for cooling the concave surface of the step shoe that turns on the lignum vitae step.

Directions for the Construction of Head and Tail Races

THE HEAD RACE

In constructing the canal or head race, a very frequent error is committed by failing to give it sufficient capacity. It should be wide and deep, and especially where the race is of considerable length, and a large quantity of water is to pass through it. As a general rule, the water should not flow faster than from 60 to 120 feet per minute. Where there is a long race, after the turbine has been running three or four hours the head frequently draws down from one to three feet. The effect of this is the same as if the dam had been lowered an equal distance—resulting in a loss of power, which would have been prevented by making the race as wide and deep as it should be.

When the water is to be conveyed through pipes to the turbines operating under low heads, the receiving ends of the pipes should be well submerged so as prevent any possibility of their drawing air. The diameter of the pipe to be recommended varies according to the quantity of water, length and contour of the pipe, head of water acting on the turbine and the head loss permissible due to friction.

THE TAIL RACE

This should be wide and deep, and the level of the bottom of the wheel pit should be carried from ten to forty feet below the end of flume, depending upon the amount of water discharged by the turbine, and if possible it should be carried out to the bed of the stream, as no tail race for even small turbines should have less than two feet of dead water in it before the turbines are put in motion, and where large turbines (using considerable water) are to be used, the tail race should have three or four feet of dead water in its entire length. By having the tail race thus constructed, as soon as the water is discharged from the turbines, it will push out or displace the dead water in the race, thus preventing a loss of head. For instance, to be more explicit, suppose the bottom of tail race is on a level with the water in main stream into which the tail

race discharges, when the turbines are started the water in tail race would rise in proportion to the width of the race and the quantity of water flowing therein, and reduce the working head in proportion; while if the race were as first above stated, the water from the turbines would displace the dead water without rising above the water in the main stream, thus utilizing the full amount of head. From one to three feet of working head is often lost for want of proper depth and width of tail race.

WHEEL PIT

Here is where mill owners and millwrights, in putting in turbines are more liable to err than elsewhere. Whether under high or low heads, the pit should be deep and wide. There is no case where this is more important than where a large turbine is run under a low head; as under these circumstances it is not desirable to lose any head whatever. A pit of insufficient size causes the water to react upon the turbine, and an additional loss of power is also caused by the fact that a portion of the head is consumed in forcing the water out of the pit when there is not sufficient outlet. As a rule, the depth of the pit should not be less than the diameter of the lower end of the draft tube.

Water has but 100 per cent. in it, and a turbine that takes out from 80 to 90 of that per cent. leaves but little force in it. To expect that the water coming through our turbines will have power to wash the sand and gravel out of their own pit, is to expect what will not be realized. Hence in putting in turbines, do not calculate upon the water in the wheel pit to do any work. If you find it foaming and dashing in the pit, then rest assured that the pit is either too shallow or too narrow, or both.

SETTING TURBINES ABOVE TAIL WATER

Sometimes in adapting turbines to high and even low heads, it becomes necessary to set the turbines some distance above the tail water and conduct the water from them through draft tubes. Better results may be obtained when turbines are set in this manner than if placed close to the tail water, provided the draft tubes are air tight and their discharge ends properly submerged. In all cases when draft tubes are used, they should be made of steel or concrete.

Directions for Setting Wheels

In setting turbines of our manufacture in a wooden penstock, the first thing to do is to see that the floor of the flume is level. Generally a ring made of soft wood is placed on the floor around the hole, on which the draft tube flange of the wheel, which is faced off, is set. It is very important that the flume be built on good foundations so as not to settle when the water is let in; a very good plan, and especially where large turbines are to be set, is to put four posts or iron columns under the timbers around the hole in the floor through which the draft tube passes.

The step and all bearings of the turbines are carefully adjusted before leaving the shops.

When turbines are shipped "knocked down," the draft tube should always be set in position first, then the runner or wheel proper placed on the step, then set the case and so on until all parts are together. When the step is properly adjusted, there will be a space between the top of the land of the runner and the bottom or inner edge of the bottom plate of ⅛". When the turbines are not to be run for some time, the step shoes should be well covered with tallow to prevent rusting.

WARRANTY

Turbines installed in accordance with our instructions and operated at speeds recommended by us, for each installation, failing to give the power guaranteed by us, can be returned if not broken, to the station to which they were shipped any time within thirty days, and the money received for such wheels will be refunded. If purchaser finds it impossible to put the turbine in and give it a trial within the thirty days allotted, and wants more time it will be granted on application, not exceeding in all sixty days from date of shipment.

S. MORGAN SMITH COMPANY.

Test and Tables of Turbines

The tables of the turbines of our manufacture are based on actual tests made in the Holyoke Testing Flume—*the only reliable testing flume in the country.* Both right and left hand turbines have been tested and brought to over 80 per cent. efficiency. Although our tables are only based on 80 per cent. useful effect from the water used, all of the turbines have exceeded 80 per cent. in the tests, *some sizes having given over 90 per cent. at less than full gate with very high average from half to full gate.*

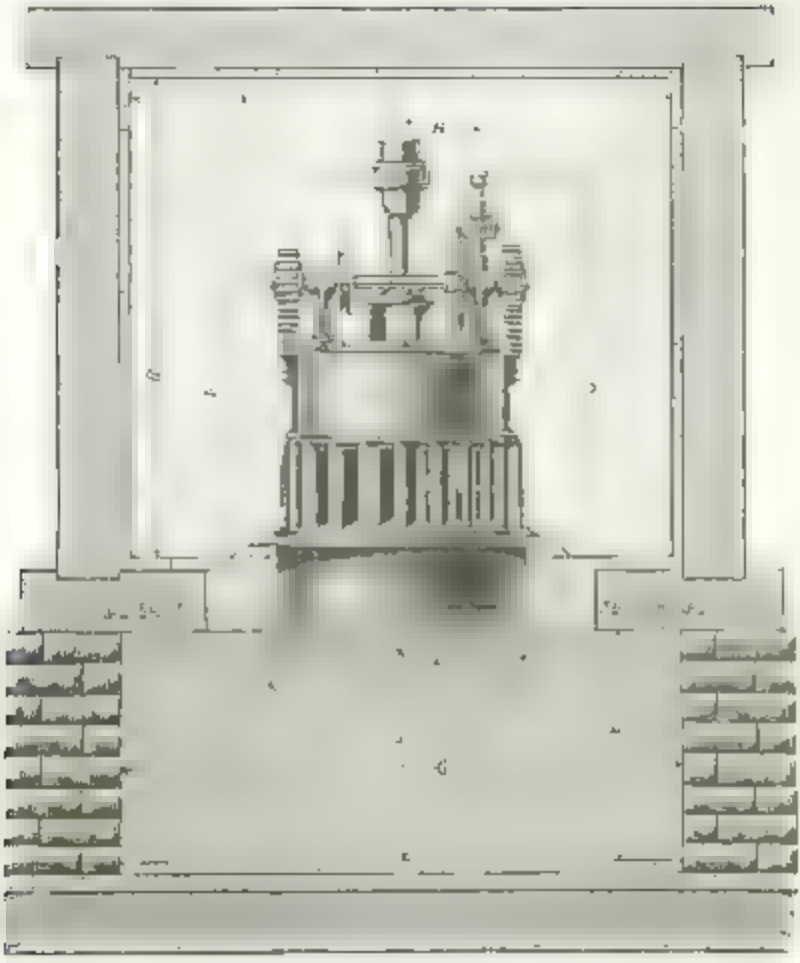
When comparing the tables of our turbines with those of other manufacturers, satisfy yourself that the tables of those turbines are reliably made. Many turbine builders have tabled their turbines at 80 or even 90 per cent., when if the truth were known, their turbines in actual test would not exceed 60 to 70 per cent.

Before purchasing a turbine be assured that the tables of the particular size turbine you require are based on actual tests made in the new flume of the Holyoke Water Power Company. Water powers are becoming more valuable each year, and the owners of water powers cannot afford to run turbines which sacrifice water and give but little power.

The following rule will enable you to determine the percentage at which any turbine is tabled.

RULE

Multiply the cubic feet of water by 62½, which is the weight of one cubic foot of water; multiply the product by the head, which will give the foot pounds; divide that product by 33,000, which gives the full horse-power of the water; divide the horse-power claimed by the full horse-power of the water, and the result will be the percentage at which the turbine is tabled.



Engraving No 403

DIMENSIONS of TURBINES and PENSTOCKS IN INCHES

Letter and numbers correspond with letters in engraving on page

Diameter of Wheel	A	B	C	D	E	F	I	J	K
4	36	9	32	24	10	13	14½	11½	18
4½	42	9½	36	27	10	15	15½	12½	22
5	48	9½	40	30	12	17	23½	23½	28
5½	54	10	44	33	12	19	24½	24½	34
6	60	10	48	36	14	21	30½	30½	39
6½	66	10½	52	39	14	23	31½	31½	45
7	72	10½	56	42	16	25	32½	32½	50
7½	78	11	60	45	16	27	33½	33½	56
8	84	11½	64	48	18	29	34½	34½	61
8½	90	11½	68	51	18	31	35½	35½	67
9	96	12	72	54	20	33	36½	36½	72
9½	102	12½	76	57	20	35	37½	37½	78
10	108	12½	80	60	22	37	38½	38½	83
10½	114	13	84	63	22	39	39½	39½	89
11	120	13½	88	66	24	41	40½	40½	94
11½	126	13½	92	69	24	43	41½	41½	100
12	132	14	96	72	26	45	42½	42½	105
12½	138	14½	100	75	26	47	43½	43½	111
13	144	14½	104	78	28	49	44½	44½	116
13½	150	15	108	81	28	51	45½	45½	122
14	156	15½	112	84	30	53	46½	46½	127
14½	162	15½	116	87	30	55	47½	47½	133
15	168	16	120	90	32	57	48½	48½	138
15½	174	16½	124	93	32	59	49½	49½	144
16	180	16½	128	96	34	61	50½	50½	149
16½	186	17	132	99	34	63	51½	51½	155
17	192	17½	136	102	36	65	52½	52½	160
17½	198	17½	140	105	36	67	53½	53½	166
18	204	18	144	108	38	69	54½	54½	171
18½	210	18½	148	111	38	71	55½	55½	177
19	216	18½	152	114	40	73	56½	56½	182
19½	222	19	156	117	40	75	57½	57½	188
20	228	19½	160	120	42	77	58½	58½	193
20½	234	19½	164	123	42	79	59½	59½	199
21	240	20	168	126	44	81	60½	60½	204
21½	246	20½	172	129	44	83	61½	61½	210
22	252	20½	176	132	46	85	62½	62½	215
22½	258	21	180	135	46	87	63½	63½	221
23	264	21½	184	138	48	89	64½	64½	226
23½	270	21½	188	141	48	91	65½	65½	232
24	276	22	192	144	50	93	66½	66½	237

9-INCH WHEEL

Head.	Revolutions per Minute	Discharge. Cubic feet per Minute	Horse Power

9-INCH WHEEL

Head	Velocity of Water in Feet per Second	Discharge Cubic Feet per Minute	Horse Power
41	85	554	36.2
42	86.1	561	37.5
43	87.1	568	38.8
44	88.2	575	40.2
45	89.2	582	41.6
46	90.2	588	43.1
47	91.2	595	44.4
48	92.2	601	45.8
49	93.2	608	47.2
50	94.2	615	48.7
51	95.2	621	50.2
52	96.2	628	51.7
53	97.2	634	53.2
54	98.2	641	54.8
55	99.2	647	56.3
56	100.2	654	57.9
57	101.2	660	59.5
58	102.2	667	61.1
59	103.2	673	62.7
60	104.2	680	64.3
61	105.2	686	66.0
62	106.2	693	67.6
63	107.2	699	69.3
64	108.2	705	71.0
65	109.2	712	72.7
66	110.2	718	74.4
67	111.2	724	76.1
68	112.2	731	77.8
69	113.2	737	79.5
70	114.2	743	81.2
71	115.2	750	83.0
72	116.2	756	84.7
73	117.2	762	86.5
74	118.2	768	88.3
75	119.2	775	90.1
76	120.2	781	91.9
77	121.2	787	93.7
78	122.2	793	95.5
79	123.2	799	97.3
80	124.2	805	99.2
81	125.2	811	101.0
82	126.2	817	102.9
83	127.2	823	104.7
84	128.2	829	106.6
85	129.2	835	108.5
86	130.2	841	110.4
87	131.2	847	112.3

12-INCH WHEEL

12-INCH WHEEL

Head	Revolutions per Minute	Discharge Cubic Feet per Minute	Horse Power
42	638	1017	6,10
43	643	1029	6,53
44	653	1041	6,96
45	660	1053	7,39
46	668	1065	7,84
47	675	1077	8,28
48	683	1089	8,73
49	690	1101	9,18
50	698	1113	9,63
51	705	1125	10,09
52	713	1137	10,55
53	720	1149	11,01
54	728	1161	11,48
55	735	1173	11,95
56	743	1185	12,42
57	750	1197	12,89
58	758	1209	13,37
59	765	1221	13,85
60	773	1233	14,33
61	781	1245	14,82
62	788	1257	15,31
63	796	1269	15,80
64	803	1281	16,30
65	811	1293	16,80
66	818	1305	17,30
67	826	1317	17,81
68	833	1329	18,32
69	841	1341	18,83
70	848	1353	19,35
71	856	1365	19,87
72	863	1377	20,39
73	871	1389	20,92
74	878	1401	21,45
75	886	1413	21,98
76	893	1425	22,52
77	901	1437	23,06
78	908	1449	23,60
79	916	1461	24,15
80	923	1473	24,70
81	931	1485	25,25
82	938	1497	25,81
83	946	1509	26,37
84	953	1521	26,93
85	961	1533	27,50
86	968	1545	28,07
87	976	1557	28,64
88	983	1569	29,22
89	991	1581	29,80
90	998	1593	30,38
91	1006	1605	30,97
92	1013	1617	31,56
93	1021	1629	32,15
94	1028	1641	32,75
95	1036	1653	33,35
96	1043	1665	33,96
97	1051	1677	34,57
98	1058	1689	35,18
99	1066	1701	35,80
100	1073	1713	36,42

15-INCH WHEEL

15-INCH WHEEL

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power
41	510	1601	[illegible]
42	516	1631	[illegible]
43	522	1661	[illegible]
44	528	1688	[illegible]
45	534	1695	[illegible]
46	540	[illegible]	[illegible]
47	546	[illegible]	[illegible]
48	552	[illegible]	[illegible]
49	558	[illegible]	[illegible]
50	563	1806	136.3
52	574	1826	[illegible]
54	585	1842	[illegible]
56	596	1854	[illegible]
58	607	1910	[illegible]
60	617	1961	[illegible]
62	627	[illegible]	[illegible]
64	637	[illegible]	[illegible]
66	647	[illegible]	[illegible]
68	657	[illegible]	[illegible]
70	666	2119	[illegible]
72	676	2149	[illegible]
[illegible]	685	[illegible]	[illegible]
[illegible]	695	[illegible]	[illegible]
78	705	2236	[illegible]
80	712	2265	[illegible]
85	741	[illegible]	[illegible]
90	769	[illegible]	[illegible]
95	796	2468	[illegible]
100	796	2532	352.6

24-INCH WHEEL

27-INCH WHEEL

Head.	Revolutions per Minute	Discharge Cubic feet per Minute.	Horse Power.
5	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]

30 INCH WHEEL

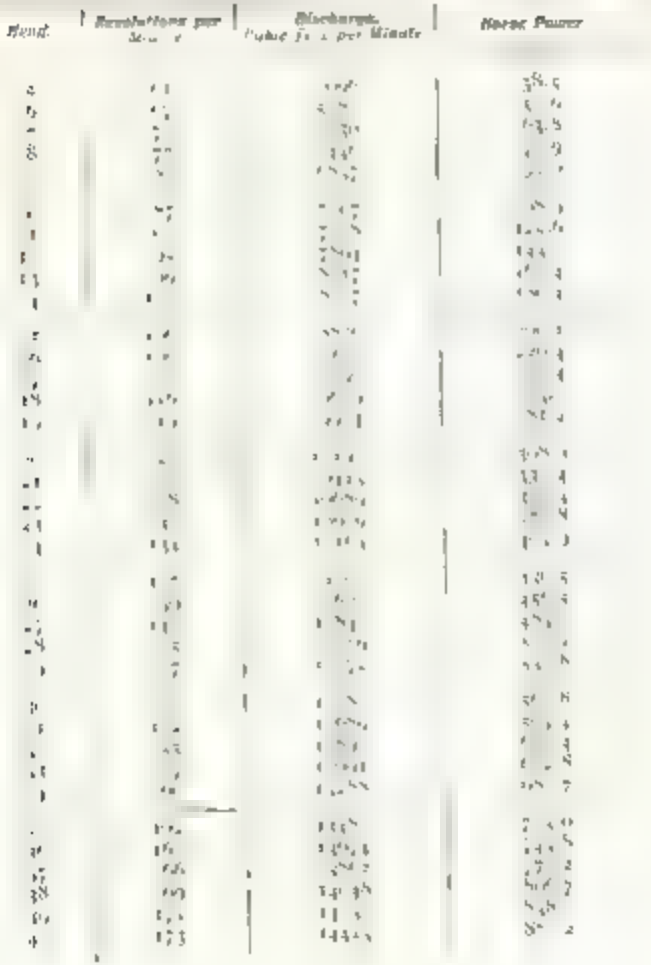
33-INCH WHEEL

Head	Revolutions per Minute	Discharge Cubic feet per Minute	Horse Power
5	86	2[illegible]3	21[illegible]
6	89	3 6[illegible]	34 9
7	96	[illegible]	33 1
8	102	[illegible]	41 2
9	109	[illegible]	50 6
10	113	[illegible]	61 7
11	116	4 [illegible]	7[illegible]
12	120	[illegible]	[illegible]
13	124	[illegible]	9[illegible] 5
14	135	[illegible]	[illegible]2
15	140	[illegible]	114 4
16	143	5 [illegible]	121 9
17	49	5 [illegible]	136 8
18	54	[illegible]	144 3
19	55	[illegible]	164 7
20	62	[illegible]	171 5
21	66	[illegible]	185 6
22	[illegible]	[illegible]	[illegible] 4
23	74	6 [illegible]	[illegible] 3
24	[illegible]	[illegible]	232 4
25	181	[illegible]	241 9
26	185	[illegible]	260 7
27	189	[illegible]	[illegible] 2
28	[illegible]	[illegible]	288 [illegible]
29	195	[illegible]	[illegible] 8
30	198	[illegible]	320 7
31	202	[illegible]	340 [illegible]
32	206	[illegible]	353 3
33	208	[illegible]	[illegible]
34	211	[illegible]	[illegible] 9
35	214	[illegible]	401 1
36	217	[illegible]	42[illegible] 6
37	220	[illegible]	440 1
38	223	[illegible]62	45[illegible] 2
39	226	[illegible]26	[illegible]5[illegible] 4
40	229	S[illegible]9	443 7

36-INCH WHEEL

39-INCH WHEEL

45-INCH WHEEL



48 INCH WHEEL

51 INCH WHEEL

Head.	Revolutions per Minute.	Discharge Cubic feet per Minute.	Horse Power
5	56	6345	45.5
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

54-INCH WHEEL

57-INCH WHEEL

Head.	Revolutions per Minute	Discharge. Cubic feet per Minute	Horse Power
5	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]
31	[illegible]	[illegible]	[illegible]
32	[illegible]	[illegible]	[illegible]
33	[illegible]	[illegible]	[illegible]
34	[illegible]	[illegible]	[illegible]
35	[illegible]	[illegible]	[illegible]
36	[illegible]	[illegible]	[illegible]
37	[illegible]	[illegible]	[illegible]
38	[illegible]	[illegible]	[illegible]
39	[illegible]	[illegible]	[illegible]
40	[illegible]	[illegible]	[illegible]

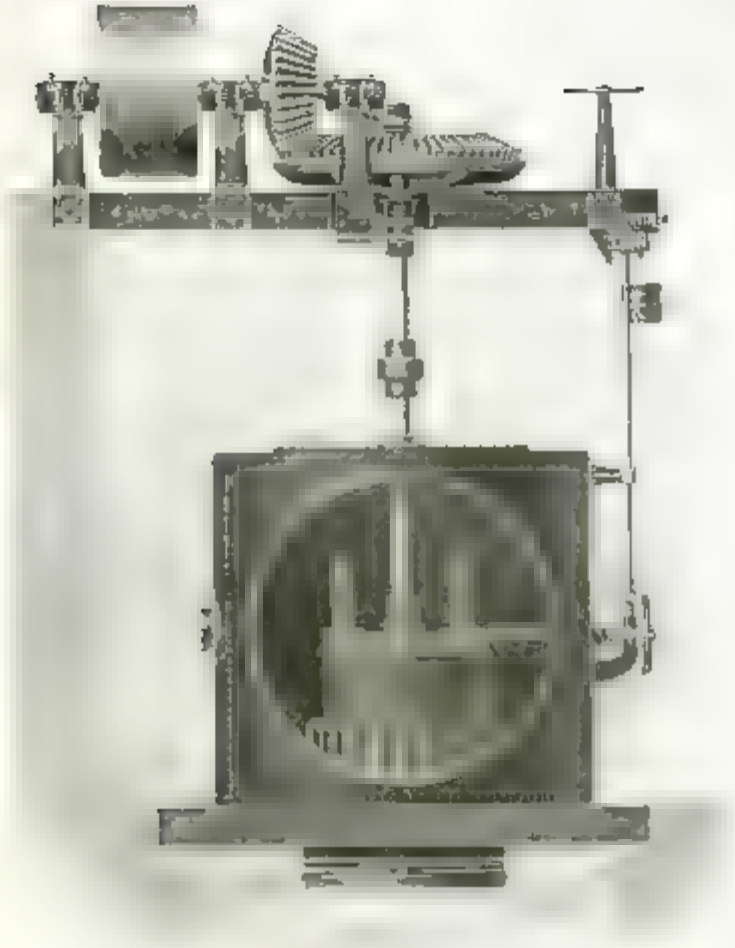
60-INCH WHEEL

66-INCH WHEEL

Head.	Revolutions per Minute.	Discharge Cubic Feet per Minute.	Horse Power
4	38	11 765	5 4
5	42	13 534	4 3
6	46	15 [illegible]	11 6
7	49	[illegible]	16 4 6
8	53	[illegible]	21 1
9	56	[illegible]	26 6
10	59	[illegible]	32
11	63	[illegible]	38 2
12	66	[illegible]	45 [illegible]
13	69	[illegible]	52 [illegible]
14	73	[illegible]	60 [illegible]
15	76	[illegible]	68 [illegible]
15½	78	[illegible]	72 [illegible]
16	79	[illegible]	76 [illegible]
16½	81	[illegible]	80 [illegible]
17	83	[illegible]	85 [illegible]
17½	86	[illegible]	89 [illegible]
18	89	[illegible]	94 [illegible]
18½	92	[illegible]	99 [illegible]
19	95	[illegible]	104 [illegible]
19½	98	[illegible]	109 [illegible]
20	101	[illegible]	115 [illegible]
20½	104	[illegible]	120 [illegible]
21	107	[illegible]	126 [illegible]
21½	110	[illegible]	132 [illegible]
22	113	[illegible]	138 [illegible]
22½	116	[illegible]	144 [illegible]
23	119	[illegible]	151 [illegible]
23½	122	[illegible]	157 [illegible]
24	125	[illegible]	164 [illegible]
24½	128	[illegible]	171 [illegible]
25	131	[illegible]	178 [illegible]
25½	134	[illegible]	185 [illegible]
26	137	[illegible]	193 [illegible]
26½	140	[illegible]	200 [illegible]
27	143	[illegible]	208 [illegible]
27½	146	[illegible]	216 [illegible]
28	149	[illegible]	224 [illegible]
28½	152	[illegible]	232 [illegible]
29	155	[illegible]	241 [illegible]
29½	158	[illegible]	249 [illegible]
30	161	[illegible]	258 [illegible]
30½	164	[illegible]	267 [illegible]
31	167	[illegible]	276 [illegible]
31½	170	[illegible]	285 [illegible]
32	173	[illegible]	294 [illegible]
32½	176	[illegible]	304 [illegible]
33	179	[illegible]	313 [illegible]
33½	182	[illegible]	323 [illegible]
34	185	[illegible]	333 [illegible]
34½	188	[illegible]	343 [illegible]
35	191	[illegible]	353 [illegible]
35½	194	[illegible]	363 [illegible]
36	197	[illegible]	374 [illegible]
36½	200	[illegible]	384 [illegible]
37	203	[illegible]	395 [illegible]
37½	206	[illegible]	406 [illegible]
38	209	[illegible]	417 [illegible]
38½	212	[illegible]	428 [illegible]
39	215	[illegible]	439 [illegible]
39½	218	[illegible]	451 [illegible]
40	221	[illegible]	462 [illegible]

72-INCH WHEEL

Mph.	Revolutions per Minute	Distance Collected per Minute	Horse Power
4	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]
31	[illegible]	[illegible]	[illegible]
32	[illegible]	[illegible]	[illegible]
33	[illegible]	[illegible]	[illegible]
34	[illegible]	[illegible]	[illegible]
35	[illegible]	[illegible]	[illegible]
36	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
38	[illegible]	[illegible]	[illegible]
39	[illegible]	[illegible]	[illegible]
40	[illegible]	[illegible]	[illegible]



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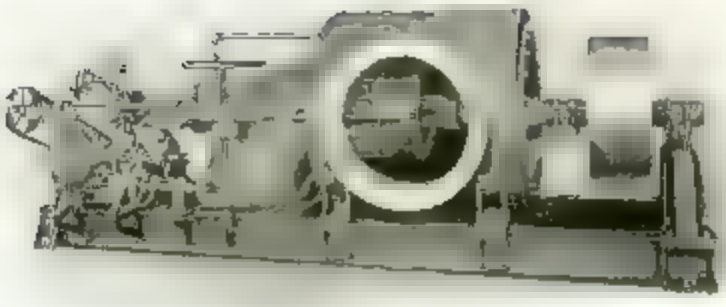

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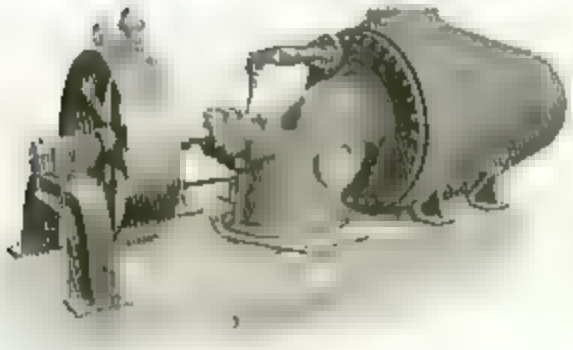

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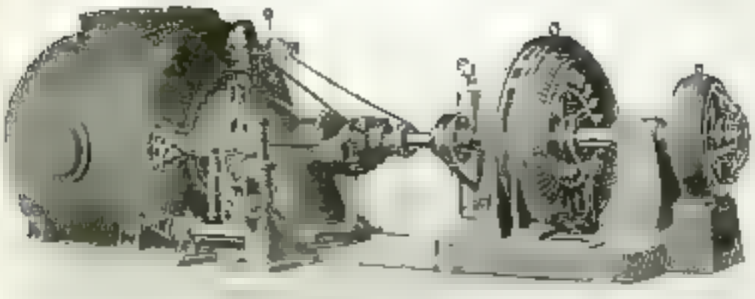
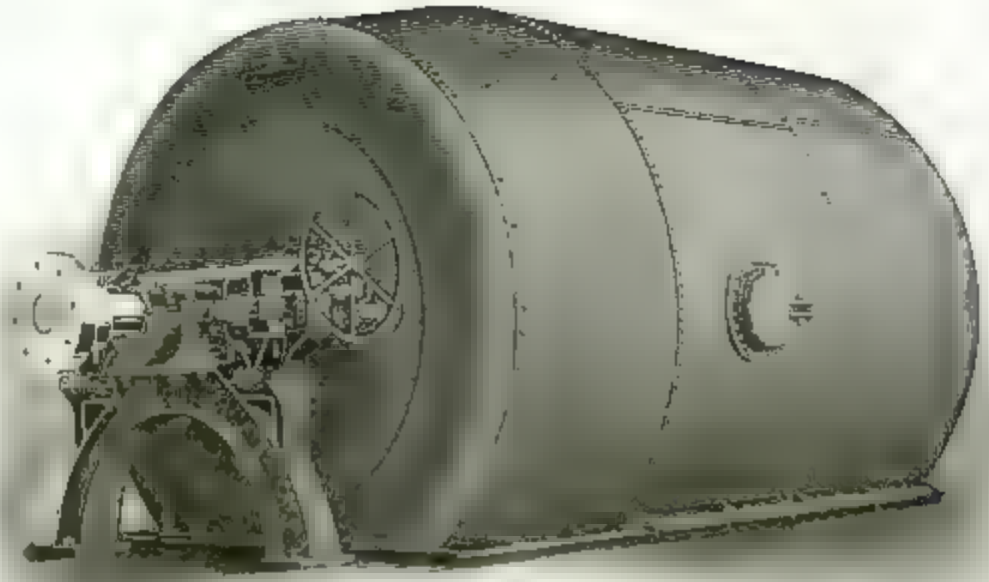


Engraving No. 408.

Engraving No. 409



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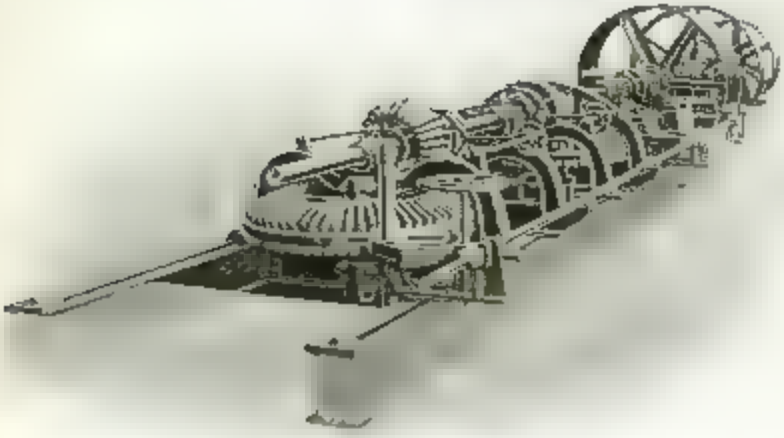

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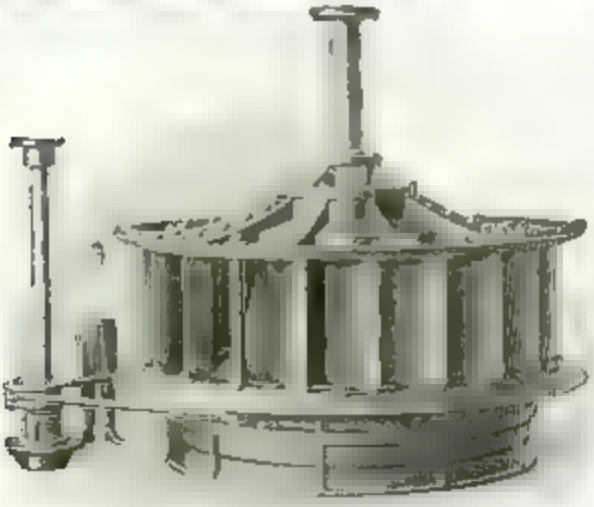


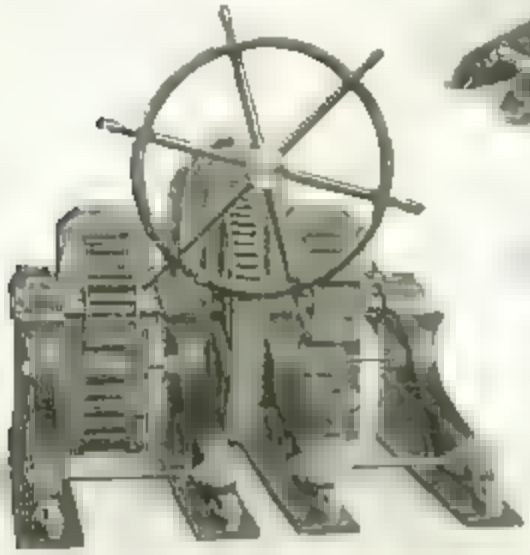
Engraving No. 412

very popular at the

Head Gate Hoists

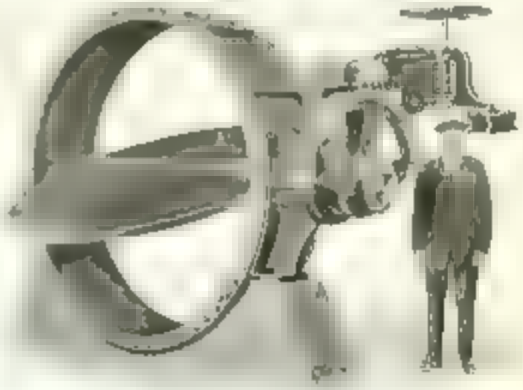
We have published special [illegible] No. 180 devoted exclusively to Head Gate Hoists and valves, copy of which will be mailed on application

Engraving No. 413



Engraving No. 414

[illegible]



Engraving No. 415

[illegible] large screw gate valve with [illegible] operating mechanism

Measurement of Large Streams

where the velo
stream is quite
m

may wash deduct 20 per cent. for losses by friction, etc.

Measurement of Water Through Openings Under Pressure

Inches	Cubic feet	Head	Cubic feet	Head									
		18											
		19											

EXAMPLE SHOWING APPLICATION OF ABOVE TABLE

Suppose the op
inches long and the gate le
opening 25
gate is

at overshot w
he head of w
by 2
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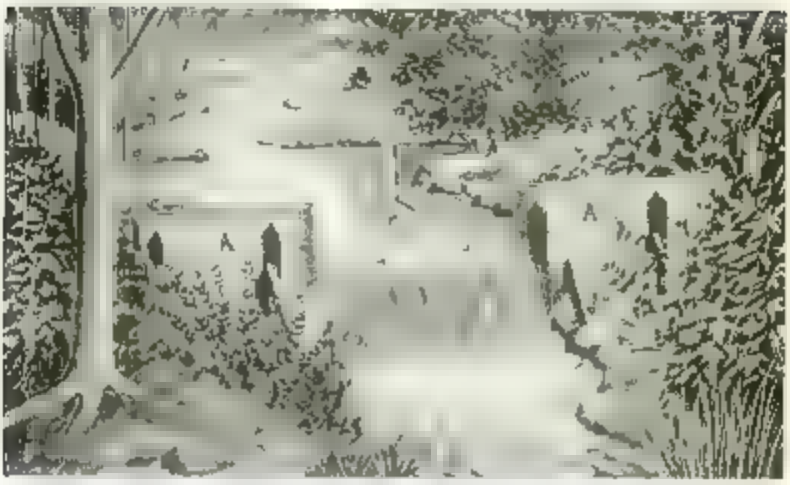
ch re
ad of
inches feet

45 inch head, w
18 fo
the number
the opening per minute

Rules for Measuring Water by Weirs



Engraving No. 416.

[illegible] first thing to do is to measure the head and [illegible] ter in the stream. The following rule is g[illegible] on the amount of water in a small stream

[illegible]

Table Showing the Quantity of Water Passing Over Weirs in Cubic Feet per Minute

Depth in inches over the crest of the weir	Cubic feet per minute passed for each inch in length of weir	Depth in inches over the crest of the weir	Cubic feet per minute passed for each inch in length of weir	Depth in inches over the crest of the weir	Cubic feet per minute passed for each inch in length of weir	Depth in inches over the crest of the weir	Cubic feet per minute passed for each inch in length of weir
1	4.85	4	50.20	7	130.18	12½	214.82
1 ⅛	5.78	4 ⅛	52.36	7 ⅛	132.82	13	220.76
1 ¼	6.68	4 ¼	54.32	7 ¼	135.32	13 ½	227.01
1⅜	7.80	4⅜	56.37	7⅜	138.14	13	233.62
1½	8.90	4½	58.33	7½	140.93	13½	240.84
1⅝	10.00	4⅝	60.43	7⅝	143.65	13⅝	247.22
1	11.21		62.55	7	146.43	14	254.13
1 ⅛	12.35		64.68	7	149.18	14	261.83
2	13.72		66.81	7	151.90	14½	269.57
2 ⅛	14.92	5	68.95	7 ⅛	154.80	14	274.70
2 ¼	16.10		71.27	7	157.64	15	281.92
2 ⅜	17.35	5	73.45	7	160.47	15	288.82
2 ½	18.67		75.72	7	163.33	15½	295.73
2 ⅝	19.96		78.01	7	166.25	15	303.11
2	22.31		80.36	7 ⅛	169.14	16	310.36
2 ⅛	23.65		82.65	7	172.07	16	317.76
2 ¼	25.00		85.04	7	174.98	16	325.14
2 ⅜	26.38		87.41	7	177.94	16	332.57
2 ½	27.83	5	89.85	7	180.93	17	340.13
2 ⅝	29.30		92.36	7	183.96	17	347.65
3	30.75	5	94.87	8	187.02	17	355.32
3 ⅛	32.26	5 ⅛	97.41	8	190.12	17 ½	362.97
3 ¼	33.82	5 ¼	99.99	8	193.26	18	370.74
3 ⅜	35.39	5 ⅜	102.59	8	196.03	18½	378.52
3 ½	36.80	5 ½	105.23	8½	199.13	18⅝	386.47
3 ⅝	38.41	5 ⅝	107.89	8	202.36	18	394.41
4	40.03	5	110.58	8	205.62	19	402.51
4 ⅛	41.69	5 ⅛	113.30	8 ⅛	208.92	19	410.63
4 ¼	43.40	5 ¼	116.05	8 ¼	212.25	19 ½	418.98
4 ⅜	45.07	5 ⅜	118.84	8 ⅜	215.62	19	427.38
4 ½	46.80	5 ½	121.66	8 ½	219.02	20	435.93
4 ⅝	48.57	5 ⅝	124.51	8 ⅝	222.46	20 ½	444.58

For explanation of above table and construction of Weirs see opposite page

Velocity of Water

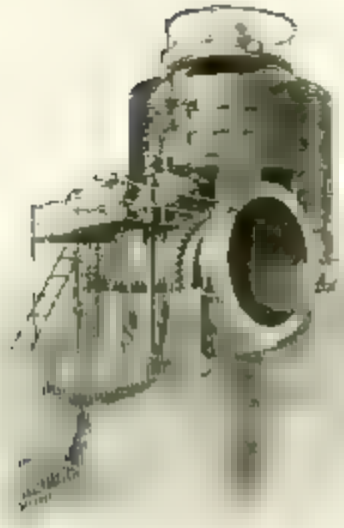
Table giving velocity of water in feet per second, and the cubic feet of water per minute, to develop one horse-power at 80 per cent. efficiency, under heads from 1 to 297 feet.

Head	Velocity	Cubic Feet	Head	Velocity	Cubic Feet	Head	Velocity	Cubic Feet
1	8.02	961.56	49	56.14	13.45	97	79.00	6.827
2	11.34	679.69	50	56.71	13.336	98	79.40	6.753
3	13.89	554.81	51	57.27	13.227	99	79.80	6.685
4	16.04	480.44	52	57.84	13.122	100	80.39	6.618
5	17.93	429.85	53	58.40	13.020	101	80.81	6.552
6	19.65	392.28	54	58.95	12.920	102	81.21	6.487
7	21.23	363.20	55	59.48	12.823	103	81.61	6.425
8	22.68	339.72	56	60.01	11.837	104	82.00	6.363
9	24.04	320.26	57	60.56	11.640	105	82.71	6.303
10	25.36	304.125	58	61.08	11.430	106	82.98	6.244
11	26.60	290.42	59	61.61	11.344	107	83.37	6.185
12	27.78	278.47	60	62.12	11.259	108	83.75	6.127
13	28.91	268.05	61	62.71	11.176	109	83.74	6.071
14	30.01	259.00	62	63.15	11.094	110	84.12	6.016
15	31.06	249.19	63	63.66	11.014	111	84.50	5.962
16	32.08	241.53	64	64.16	10.936	112	84.88	5.910
17	33.07	234.07	65	64.66	10.859	113	85.25	5.858
18	34.04	227.76	66	65.16	10.784	114	85.63	5.8105
19	34.98	221.56	67	65.65	10.710	115	86.00	5.7565
20	35.89	215.45	68	66.14	10.637	116	86.36	5.7035
21	36.79	210.41	69	66.62	10.565	117	86.73	5.650
22	37.67	205.39	70	67.11	10.494	118	87.12	5.6004
23	38.53	201.32	71	67.58	10.424	119	87.49	5.5515
24	39.38	197.22	72	68.06	10.355	120	87.86	5.5034
25	40.19	193.17	73	68.53	10.287	121	88.22	5.4563
26	41.00	189.36	74	69.00	10.220	122	88.58	5.4100
27	41.79	185.71	75	69.46	10.154	123	88.94	5.3645
28	42.54	182.34	76	69.92	10.089	124	89.30	5.3197
29	43.29	179.06	77	70.38	10.025	125	89.66	5.2758
30	44.03	175.96	78	70.84	9.962	126	90.02	5.2327
31	44.75	173.01	79	71.29	9.900	127	90.38	5.1903
32	45.47	170.19	80	71.74	9.839	128	90.74	5.1487
33	46.17	167.50	81	72.19	9.779	129	91.09	5.1078
34	46.86	164.93	82	72.64	9.720	130	91.44	5.0677
35	47.55	162.48	83	73.08	9.661	131	91.79	5.028
36	48.23	160.13	84	73.52	9.604	132	92.14	4.989
37	48.90	157.88	85	73.96	9.547	133	92.49	4.950
38	49.56	155.73	86	74.40	9.491	134	92.84	4.911
39	50.20	153.66	87	74.84	9.436	135	93.19	4.872
40	50.85	151.68	88	75.27	9.381	136	93.54	4.833
41	51.48	149.78	89	75.70	9.327	137	93.88	4.795
42	52.11	147.96	90	76.13	9.274	138	94.23	4.757
43	52.73	146.21	91	76.56	9.222	139	94.58	4.720
44	53.34	144.53	92	76.98	9.170	140	94.92	4.683
45	53.95	142.92	93	77.41	9.119	141	95.27	4.646
46	54.55	141.37	94	77.83	9.069	142	95.61	4.610
47	55.15	139.88	95	78.25	9.019	143	95.96	4.574
48	55.74	138.45	96	78.67	8.970	144	96.30	4.539

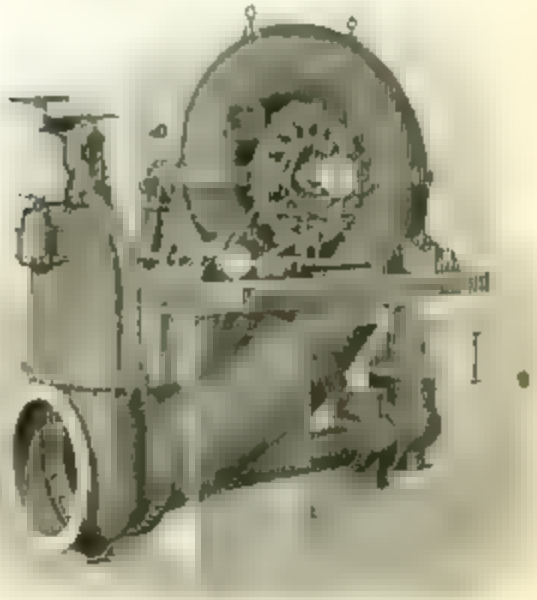
VELOCITY OF WATER Continued

[illegible]	[illegible]	Cubic Feet	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Cubic Feet
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

"Francis" Turbines

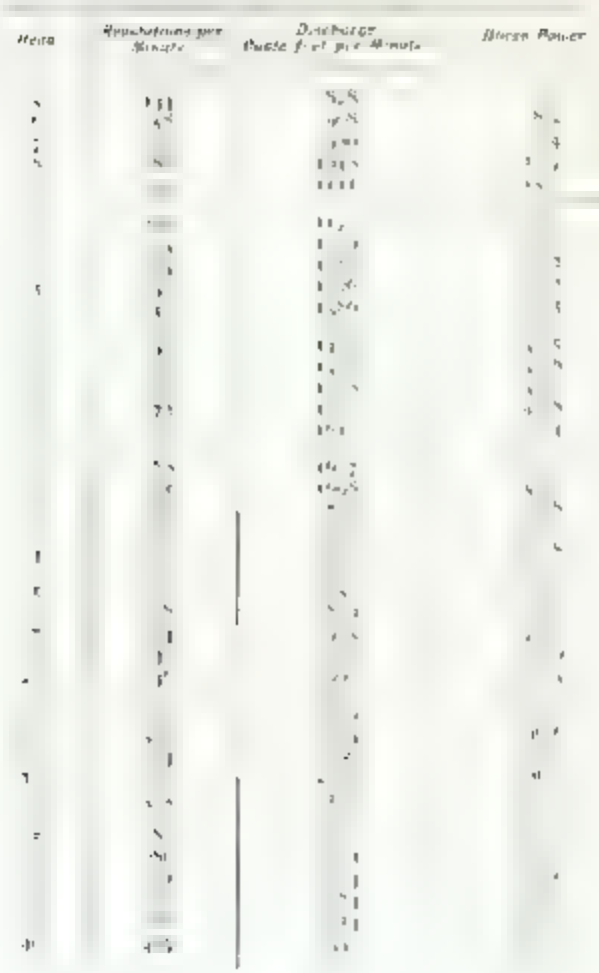


Engraving No. 417



Engraving No. 418.

18-INCH WHEEL

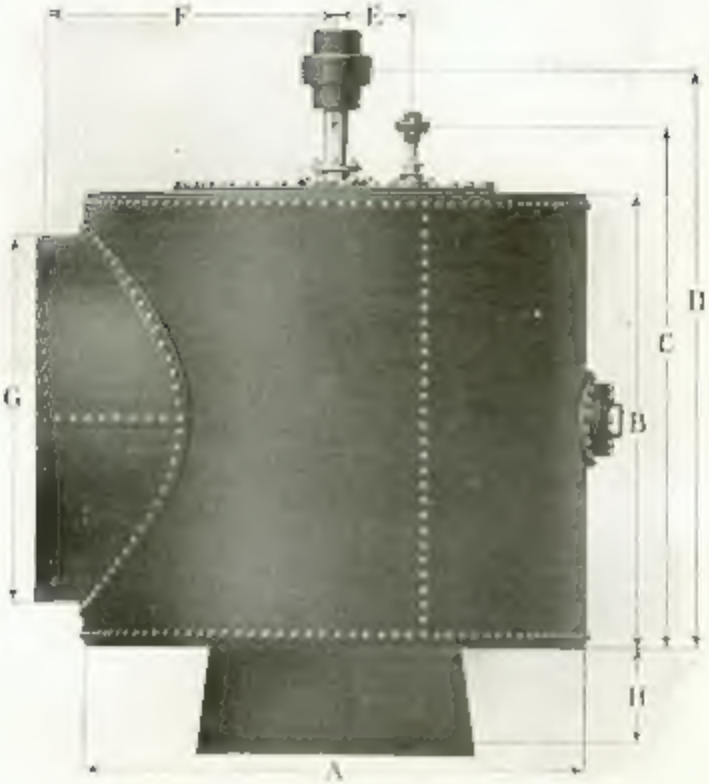


21-INCH WHEEL

Head	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	137	1172	8.9
6	150	1283	11.0
7	162	1386	14.7
8	173	1482	17.9
9	184	1572	21.4
10	194	1657	25.0
11	203	1738	28.9
12	212	1815	32.9
13	221	1889	37.1
14	229	1960	41.5
15	237	2029	46.0
16	245	2096	50.7
17	253	2160	55.5
18	260	2223	60.5
19	267	2284	65.6
20	274	2343	70.8
21	281	2401	76.2
22	287	2457	81.7
23	294	2513	87.3
24	300	2567	93.1
25	306	2620	99.0
26	312	2672	105.0
27	318	2722	111.1
28	324	2772	117.3
29	330	2821	123.6
30	336	2870	130.1
31	341	2917	136.6
32	347	2964	143.3
33	352	3010	150.1
34	357	3055	157.0
35	362	3100	163.9
36	368	3144	171.0
37	373	3187	178.2
38	378	3230	185.5
39	383	3272	192.8
40	387	3314	200.3

42-INCH WHEEL

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	67	4786	36.2
6	74	5242	47.5
7	80	5662	59.9
8	85	6053	73.2
9	90	6421	87.3
10	95	6768	102.3
11	100	7098	118.0
12	104	7414	134.4
13	108	7717	151.6
14	112	8008	169.4
15	116	8289	187.9
16	120	8561	207.0
17	124	8824	226.7
18	128	9080	247.0
19	131	9329	267.8
20	134	9571	289.3
21	138	9808	311.2
22	141	10038	333.7
23	144	10264	356.7
24	147	10485	380.2
25	150	10701	404.2
26	153	10913	428.7
27	156	11121	453.7
28	159	11325	479.1
29	162	11525	505.0
30	165	11722	531.4
31	167	11916	558.2
32	170	12107	585.4
33	173	12294	613.1
34	175	12479	641.1
35	178	12661	669.6
36	180	12841	698.5
37	183	13018	727.8
38	185	13193	757.5
39	188	13365	787.6
40	190	13536	818.1



Engraving No. 405.

The price of steel flumes usually exceeds the cost of those constructed from wood, but for many locations they are more desirable on account of their durability and freedom from leakage.

Each flume has a heavy cast iron top and bottom. The top is provided with a lid of sufficient size to admit the wheel and contains packing boxes for wheel and gate shafts.

A man door is conveniently located on the side of the flume affording easy access to the water wheel. See dimensions of flumes on page 37.

DIMENSIONS OF STEEL FLUMES IN INCHES

Lettered columns correspond with letters in Engraving No. 495

Diameter of Wheel	A	B	C	D	E	F	G	H
9	36	36		57½	Dimensions given upon application	24	24	6½
12	42	42		64½		27	30	7⅛
15	48	48		70½		30	36	9⅛
18	54	54	69½	76½		33	42	10⅝
21	60	60	75½	83		38	48	12⅛
24	72	70	85½	93		44	54	13⅜
27	84	76	91½	99		50	60	15⅛
30	90	82	97½	106½		53	66	16⅜
33	96	88	103½	113		56	72	18⅛
36	102	96	114½	123		59	78	21⅜
39	108	102	120½	128½		62	84	22⅛
42	114	108	126½	137½		65	90	25¼
45	120	112	130½	142½		68	94	26⅜
48	126	114	132½	144½		71	96	28⅛
51	132	118	139½	152½		74	100	29¾
54	144	122	144	156½		80	104	21⅝
57	156	126	148	161¾		86	108	33⅛
60	168	132	154	167½		92	114	35
66	180	138	160	173¾		98	120	41
72	200	162	184	197¼		108	144	46¾